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(54) RESIN MOLD FOR PRODUCING CONTACT LENS AND PRODUCTION OF CONTACT LENS

(57)Abstract:

PURPOSE: To inexpensively produce a contact lens of high quality excellent in optical properties and mechanical strength and having a smooth surface and edge imparting no damage to the cornea.

CONSTITUTION: The production of a contact lens is performed by a blank molding method due to thermosetting and, as the material quality of a resin mold used therein, a resin capable of sufficiently withstanding thermosetting and thermal annealing and susceptible to cutting processing using a lathe is used.

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CLAIMS

[Claim(s)]

[Claim 1] The space formed when a male and a female mold are combined is filled up with a polymerization nature monomer. After carrying out a polymerization by heating this, are in a condition [that both molds have agreed], or a male is attached in the engine lathe for lens cutting where a female mold is removed. It is the mold used for the approach of carrying out cutting of the front curve side of a lens, and manufacturing a contact lens. The plastic pattern for contact lens manufacture which the quality of the material of this plastic pattern is resin which can bear heat curing and heating annealing enough, and is characterized by consisting of resin with an engine lathe in which cutting is possible.

[Claim 2] The space formed when a male and a female mold are combined is filled up with a polymerization nature monomer. After carrying out a polymerization by heating this, are in a condition [that both molds have agreed], or a male is attached in the engine lathe for lens cutting where a female mold is removed. The plastic pattern for contact lens manufacture characterized by being the mold used for the approach of carrying out cutting of the front curve side of a lens, and manufacturing a contact lens, and the thickness of the space formed when the male and female mold of this plastic pattern are combined being 0.3mm or more.

[Claim 3] The plastic pattern for contact lens manufacture according to claim 1 or 2 characterized by being resin which can be fabricated by the quality of the material of a plastic pattern with injection molding.

[Claim 4] The plastic pattern for contact lens manufacture according to claim 1 to 3 characterized by the quality of the material of a plastic pattern consisting of a polyamide, an ethylene-vinylalcohol copolymer, polyacetal, polyester, polysulfone, and resin chosen from amorphous polyolefine.

[Claim 5] The quality of the material of a plastic pattern is resin which can bear heat curing and heating annealing enough. And consist of resin with an engine lathe in which cutting is possible, and this male and female mold are combined. After carrying out a polymerization by filling up with a polymerization nature monomer the space formed between them, and heating this, it is in a condition [that both molds have agreed] -- it is -- the manufacture approach of the contact lens characterized by attaching a male in the engine lathe for lens cutting where a female mold is removed, and carrying out cutting of the front curve side of a lens.

[Claim 6] It combines so that the thickness of the space formed when a male and a female mold are combined may be set to 0.3mm or more. After carrying out a polymerization by filling up with a polymerization nature monomer the space formed between them, and heating this, it is in a condition [that both molds have agreed] -- it is -- the manufacture approach of the contact lens characterized by attaching a male in the engine lathe for lens cutting where a female mold is removed, and carrying out cutting of the front curve side of a lens.

[Claim 7] The manufacture approach of the contact lens according to claim 5 or 6 characterized by being resin which can be fabricated by the quality of the material of a plastic pattern with injection molding.

[Claim 8] The manufacture approach of the contact lens according to claim 5 to 7 characterized by the quality of the material of a plastic pattern consisting of a polyamide, an ethylene-vinylalcohol copolymer, polyacetal, polyester, polysulfone, and resin chosen from amorphous polyolefine.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention is excellent in the optical character and a mechanical strength, and relates to the plastic pattern for contact lens manufacture used in order to manufacture the quality contact lens which has the smooth front face and smooth edge which do not do damage to a cornea by low cost, and the manufacture approach of a contact lens.

[0002]

[Description of the Prior Art] A contact lens is roughly divided and is manufactured by one approach of three kinds of manufacture approaches (the cutting grinding method), i.e., the ball-race cutting method, the mold method, and the spin cast method (centrifugal casting method). The ball-race cutting method is an approach most generally used to manufacture of a current contact lens, and is cylindrical or a method of cutting down a carbon button-like contact lens ingredient with an engine lathe, performing cutting and polish, and manufacturing a contact lens. Although this approach is an approach suitable for manufacturing the contact lens of the many forms with which configurations, such as BC (base curve: the field where a contact lens touches a cornea, or curvature of that field), differed, there is a problem that a manufacturing cost is high. It is manufactured by this ball-race cutting method, and, as for most of current and hard lenses, many manufacturers are also manufacturing the soft contact lens using the ball-race cutting method.

[0003] On the other hand, the mold method and the spin cast method are approaches by which most is used for manufacture of a soft contact lens. It is the approach of the mold method filling up with a polymerization nature monomer the die which has the space of a lens configuration, carrying out the polymerization of this, and manufacturing a contact lens, and the spin cast method is an approach of manufacturing a contact lens using slushing into the mold turning around a polymerization nature monomer, and a raw material spreading thinly with a centrifugal force. When manufacturing flexibly the contact lens of the many forms with which configurations differed, I hear that the fault of these approaches becomes disadvantageous, and there is, but in the case of a soft contact lens, since there are few classes of mold for which the class of BC is needed few, it becomes applicable [these approaches]. On the other hand, although the advantage of these approaches is being able to manufacture a contact lens by low cost, if dimensional accuracy and profile irregularity are greatly influenced by both the precision of a mold and an accurate mold is used, it is specifically possible the precision and to manufacture a quality contact lens. However, the spin cast method will need to control many factors, such as viscosity of a polymerization nature monomer, surface tension, an amount, and a rotational frequency, and an applicable lens ingredient will also be limited to a specific thing. Moreover, the contact lens obtained by this approach is the aspheric surface, and has the description that sufficient optical-character ability is not obtained.

[0004] In recent years, the soft contact lens is widely used for people who were not able to wear the conventional hard lens, and a soft contact lens wearing person's rate is increasing it from the goodness of the

feeling of wearing even in Japan which the rate of past hard lens wearing population had. Therefore, the technique of manufacturing a quality soft contact lens by low cost has been variously performed by the hand of researchers or engineers. As a description of a soft contact lens, the lens itself is flexible, and since it is equipped in accordance with a cornea configuration, the class of many BC is not needed like a hard lens. Therefore, although it is thought that the mold method is suitable in order to manufacture a contact lens with little dispersion in quality by low cost, as stated also in advance, the mold method has the problem that a limitation is in that the contact lens of the many forms with which configurations differed cannot be manufactured flexibly, or the quality of an edge section configuration. The approach which combined the mold method for the ability to manufacture a contact lens with little dispersion in quality by low cost as an effective means to solve the trouble of this mold method, and the ball-race cutting method for the ability to manufacture flexibly the contact lens of the many forms with which configurations differed is proposed. For the purpose of manufacturing a half-completion lens by the mold method, this approach will be called the blank mold method.

[0005] the blank mold method have the description which it not only can set up a frequency and main thickness freely, but can perform formation of the edge section easily by make a cutting tool cut deeply to BC side, in order to form BC side with few classes by the mold method, to carry out cutting of the FC (front curve: field [of the opposite side of the field where a contact lens contact a cornea], or curvature of the field) side to the curvature of arbitration and to form it by the ball race cut method.

[0006] When manufacturing a contact lens by this approach, by the resin mold manufactured by injection molding, BC side of a lens is formed, and after that, a lens semifinished product attaches in the engine lathe for lens cutting in the condition of having adhered to resin mold, and forms FC side and the edge section. Furthermore, FC side and the edge section which were formed by cutting must be smoothly ground so that damage may not be done to a cornea at the time of contact lens wearing. Under the present circumstances, sufficient adhesion to which a lens semifinished product bears the stress added at the time of processing in cutting or the polish process of FC side and the edge section is required. And after giving cutting and a polish process and forming a lens configuration, a mold-release characteristic which separates easily from resin mold by hide rhe SHON by water etc. is required. That is, adhesion and a mold-release characteristic need to be balanced between the plastic patterns and lens ingredients which are used for the blank mold method.

[0007] Conventionally, as the quality of the material of the plastic pattern for contact lens manufacture, the synthetic resin in which injection molding is possible, such as polyolefines, such as PP (polypropylene) and PE (polyethylene), PS (polystyrene), PC (polycarbonate) and PMMA (polymethylmethacrylate), Teflon, and nylon, is mainly used widely. In order to choose from these the ingredient used for the plastic pattern for contact lens manufacture, it is necessary to take various elements into consideration.

[0008] Compatibility with a contact lens ingredient is mentioned in the first place. The quality of the material of the plastic pattern for contact lens manufacture must not be corroded when the various polymerization nature monomers which are contact lens raw materials are contacted. This changes with classes of polymerization nature monomer to be used. Moreover, adhesion with a contact lens ingredient also poses a big problem as mentioned above. For example, when the adhesion of the quality of the material of the plastic pattern for contact lens manufacture and a contact lens ingredient is too large, there is a problem which cannot be released from mold, after carrying out the polymerization of the contact lens raw material. Since it separates from a plastic pattern easily and the configuration of a plastic pattern is not correctly imprinted by the contact lens contrary to this in the process in which the polymerization nature monomer which is a contact lens raw material carries out a polymerization even if adhesion is too small, it becomes a problem. That is, it is necessary to choose the quality of the material of the plastic pattern for contact lens manufacture so that adhesion with a contact lens raw material may become suitable.

[0009] Then, the relation between a polymerization method or polymerization conditions is mentioned. the polymerization nature monomer used as the raw material of a contact lens -- usually -- the exposure of activity

energy lines, such as heating under existence of a polymerization initiator, or ultraviolet rays, -- a polymerization -- it hardens. Since it is performed by thermal polymerization in the case of this invention, the plastic pattern used for it must have a certain amount of thermal resistance.

[0010] Furthermore, although the precision as a plastic pattern for contact lens manufacture is mentioned, this has the close relation to the shaping approaches, such as injection molding. Although the precision as a plastic pattern for contact lens manufacture specifically shows dimensional accuracy and profile irregularity, this is greatly influenced by the quality of the material of the resin to be used. It is known that the volumetric shrinkage at the time of shaping, the water absorption after shaping, etc. will have big effect on the precision of a plastic pattern especially.

[0011] Besides these elements, the cost of the ingredient of a plastic pattern, a moldability, and since it is necessary to carry out cutting of the plastic pattern with the engine lathe for lens cutting by this invention further, the workability of a plastic pattern and cutting ability are one of the important elements.

[0012]

[Problem(s) to be Solved by the Invention] The greatest advantage which manufactures a contact lens by the mold method can manufacture the contact lens of the same specification in large quantities, and I hear that low cost production is possible for it, and there is.

[0013] Since troublesome cares, such as washing of a soft contact lens and sterilization-by-boiling processing, are not needed but it says in recent years that it is sanitary, a disposable soft contact lens is beginning to spread quickly mainly by the United States. Although it is necessary to reduce the conventional manufacturing cost sharply in order to manufacture this disposable soft contact lens, quality cannot be reduced if a contact lens is the medical device referring to a direct cornea at all.

[0014] As a technical problem which it is going to solve in this invention, the class of ingredient first used for a plastic pattern is mentioned. PP said to be used most generally as the quality of the material of current and the plastic pattern for contact lens manufacture is called polyolefine with PE etc. Polyolefine has the description that it is generally cheap and can fabricate with injection molding etc. easily. Moreover, since it has a certain amount of transparency, it is applicable also to a polymerization with a beam of light. However, since thermal resistance of polyolefine is bad, it is not only difficult for the volumetric shrinkage at the time of shaping to take out precision comparatively greatly, but it has a possibility that deformation may arise also at low temperature comparatively. Therefore, when manufacturing a contact lens by thermal polymerization, it cannot be said that it is suitable. Although thermal resistance is greatly excellent also in transparency compared with PP, solvent resistance of PS is not good. Although PC and PMMA are excellent in transparency as used as various optical materials, thermal resistance of PC is large and PMMA has the description which can take out precision easily, solvent resistance is both comparatively bad, and there is a possibility of corroding to the polymerization nature monomer generally used especially as a contact lens ingredient. Furthermore, adhesion with a contact lens ingredient also has the fault that it is large and mold release is difficult.

[0015] Then, the technical problem on the polymerization of a contact lens is described. The polymerization of current and a contact lens is mainly performed by heat curing. The most may especially say that it is manufactured by the polymerization of the bar material which is the contact lens ingredient used for the ball-race cutting method, or a carbon button according to heat curing. It is manufactured by not only heat curing but photo-curing about the mold method and the spin cast method. Here, the effect on the lens property by the difference in the hardening approach of heat curing and photo-curing is described. It is said that the copolymer obtained according to heat curing is generally excellent in a mechanical-strength property compared with the copolymer obtained by photo-curing. When heat curing repeats the chain reaction of a small amount of heat catalyst added in the polymerization nature monomer generating cleavage and a radical with heating, and this radical attacking a polymerization nature monomer, and joining together, macromolecule-ization of a polymerization nature monomer is performed. Although macromolecule-ization of

a polymerization nature monomer is performed because the little photocatalyst added in the polymerization nature monomer like [photo-curing] heat curing generates cleavage and a radical by the exposure of activity energy lines, such as ultraviolet rays A big difference here is the point that there is an inclination for polymerization degree not to become large enough compared with heat curing, in order that a photocatalyst may moreover cleave quickly by the exposure of a beam of light at a coincidence term and a radical may generate. Therefore, compared with the copolymer manufactured according to heat curing, molecular weight becomes small, and, in the case of the reinforcement and the hard lens to hauling, the copolymer manufactured by photo-curing is considered that the reinforcement to bending is inferior the case of a mechanical-strength property, for example, a soft contact lens.

[0016] On the other hand, photo-curing can complete hardening very much for a short time compared with heat curing, and the advantage on manufacture is large. However, in order to obtain the quality contact lens which has sufficient mechanical strength made into the purpose of this invention, it can be said that manufacturing according to heat curing now is suitable.

[0017] The manufacture approach of the contact lens of this invention is a heat-curing method using the blank mold method. It is the homogeneous problem of the copolymer after hardening a polymerization nature monomer to become a technical problem here. In the polymerization of a contact lens, polymerization distortion originating in the heterogeneity of copolymerization is often made into the problem. In the case of the bar material or carbon button which is the contact lens ingredient used for the ball-race cutting method as a means for losing this polymerization distortion conventionally, it is carried out by approaches, such as optimization of polymerization conditions, or heating annealing after a polymerization, but it is a quite difficult technical problem to lose polymerization distortion completely. Especially in the case of a single component, it is not a so difficult thing as a polymerization nature monomer, but in the case of copolymerization by two or more components, the problem that this is big can be posed.

[0018] As mentioned above, although the technical problem from the resin ingredient of the plastic pattern for contact lens manufacture and the field of a configuration, or the field of the heterogeneity at the time of a polymerization has been described, the actual condition is that a plastic pattern and the manufacture approach for contact lens manufacture which fulfill enough the property still needed for a contact lens are not found out. Especially, a contact lens is a medical device, and while the precision is required severely, this invention is excellent in the optical character and a mechanical strength, and aims at manufacturing the quality contact lens which has the smooth front face and smooth edge which do not do damage to a cornea by low cost.

[0019]

[Means for Solving the Problem] Namely, the plastic pattern for contact lens manufacture of this invention The space formed when a male and a female mold are combined is filled up with a polymerization nature monomer. After carrying out a polymerization by heating this, are in a condition [that both molds have agreed], or a male is attached in the engine lathe for lens cutting where a female mold is removed. It is the mold used for the approach of carrying out cutting of the front curve side of a lens, and manufacturing a contact lens, and the quality of the material of this plastic pattern is resin which can bear heat curing and heating annealing enough, and it is characterized by consisting of resin with an engine lathe in which cutting is possible.

[0020] Furthermore, the space formed when a male and a female mold are combined is filled up with a polymerization nature monomer. After carrying out a polymerization by heating this, are in a condition [that both molds have agreed], or a male is attached in the engine lathe for lens cutting where a female mold is removed. It is the mold used for the approach of carrying out cutting of the front curve side of a lens, and manufacturing a contact lens, and is characterized by the thickness of the space formed when the male and female mold of this plastic pattern are combined being 0.3mm or more.

[0021] Moreover, the manufacture approach of the contact lens of this invention The quality of the material of a plastic pattern is resin which can bear heat curing and heating annealing enough. And consist of resin with

an engine lathe in which cutting is possible, and this male and female mold are combined. After carrying out a polymerization by filling up with a polymerization nature monomer the space formed between them, and heating this, it is in a condition [that both molds have agreed] -- it is -- where a female mold is removed, a male is attached in the engine lathe for lens cutting, and it is characterized by carrying out cutting of the front curve side of a lens.

[0022] Furthermore, it combines so that the thickness of the space formed when a male and a female mold are combined may be set to 0.3mm or more. After carrying out a polymerization by filling up with a polymerization nature monomer the space formed between them, and heating this, it is in a condition [that both molds have agreed] -- it is -- where a female mold is removed, a male is attached in the engine lathe for lens cutting, and it is characterized by carrying out cutting of the front curve side of a lens.

[0023] Hereafter, this invention is explained to a detail.

[0024] The plastic pattern for contact lens manufacture of this invention is a plastic pattern used for the blank mold method which forms BC side of a contact lens by the mold method, and forms FC side by the ball-race cutting method. Furthermore, it is characterized by hardening the polymerization nature monomer in the inside of mold with heat.

[0025] In the first place, the ingredient used for the plastic pattern of this invention is stated. Since manufacture of the contact lens of this invention is performed by heat curing like point **, as a resin ingredient used for it, you have to have a certain amount of thermal resistance. That is, in 20-100 degrees C which is the temperature requirement generally used for heat curing of a polymerization nature monomer, the sufficient dimensional accuracy and the profile irregularity which are required of a contact lens must be maintained. Furthermore, generally heating of 100 degrees C or more may be performed by manufacture of the contact lens by heat curing by annealing. Although the purpose of heating annealing is for removing the active spot which may remain in the homogeneous improvement in a copolymer, and a copolymer as stated also in advance, the plastic pattern used for this invention must not deform with this annealing temperature.

[0026] On the other hand, since the manufacture approach of the contact lens of this invention is the blank mold method, after forming BC side by the mold method, it is necessary to carry out cutting of the FC side with the engine lathe for lens cutting. Furthermore, in order to process into a smooth curve configuration the edge section which influences the feeling of wearing of a contact lens, it is necessary to make the cutting edge of the cutting tool of an engine lathe cut deeply to a plastic pattern, and to process it. Then, the plastic pattern used for this invention must choose the resin in which cutting with an engine lathe is possible.

[0027] Therefore, as the quality of the material usable as resin die materials of this invention, thermal resistance can mention the polyamide which is resin in which cutting is good and possible, an ethylene-vinylalcohol copolymer, polyacetal, polyester, polysulfone, amorphous polyolefine, etc., and, generally uses it in consideration of adhesion with a lens ingredient further out of these in consideration of the class of polymerization nature monomer to be used, a polymerization or annealing temperature, cutting conditions, etc. as point **, choosing. Especially an ethylene-vinylalcohol copolymer cannot receive corrosion easily to the acrylic ester generally used as a contact lens raw material (meta), and since it is usable in a very wide range contact lens raw material, it can say it as a suitable ingredient.

[0028] Then, the plastic pattern for contact lens manufacture of this invention is described. The semifinished product (blank) of the contact lens in which only BC of a contact lens was formed is produced by the mold method, and a drawing (drawing 1 - drawing 3) explains the plastic pattern used for the approach of carrying out fabricating of the FC after that, and obtaining a contact lens. The sectional view of the male of the contact lens plastic pattern according [drawing 1] to this invention and drawing 2 are the sectional views of a female mold, and drawing 3 is the built-up-section Fig. showing the integrated state of the contact lens plastic pattern by this invention.

[0029] The male of this contact lens die consists of attachments 3 when attaching in the engine lathe for lens cutting, after carrying out a polymerization, the contact surface 2 of the mold which contacts when combining

a mold, after being filled up with the convex BC optical surface 1 and polymerization nature monomer which form BC, when it fabricates in a contact lens configuration, as shown in drawing 1, and. When it fabricates in a contact lens configuration, the convex BC optical surface 1 which forms BC is processed on the mirror plane smooth enough. On the other hand, a female mold consists of the contact surface 5 of the mold which contacts when combining a mold after being filled up with a polymerization, the concave FC forming face 4 which forms FC of a contact lens after carrying out cutting, and a polymerization nature monomer as shown in drawing 2, and the lateral portion contact surface 6 of the mold which prevents gap of the location of FC side and BC side.

[0030] If it agrees and these males and female molds are assembled, as shown in drawing 3, the space (mold cavity) 7 which constitutes a lens configuration will be formed between FC forming face and BC optical surface. after being filled up with a polymerization nature monomer in the mold cavity and carrying out the polymerization of this, it is in a condition [that both molds have agreed] -- it is -- where a female mold is removed, a male is attached in the engine lathe for lens cutting through an attachment, cutting of the FC side of a lens is carried out, and a contact lens is obtained.

[0031] In this case, it becomes the one point how the thickness of a blank is set up. As stated previously, it is the homogeneous problem of the copolymer after hardening a polymerization nature monomer to be mentioned as one of the technical problems on contact lens manufacture. That is, in the polymerization of a contact lens, although polymerization distortion originating in the heterogeneity of copolymerization is often made into a problem, this phenomenon is similarly produced, not only when manufacturing by the ball-race cutting method, but when manufacturing by the mold method and the spin cast method. Since the thickness of the mold cavity described previously serves as lens thickness made into the purpose in manufacturing a lens by the mold method, it becomes 0.03mm - 0.2mm and a very thin thing. For this reason, the chain reaction by the polymerization does not progress equally, but causes polymerization distortion. Furthermore, although oxygen acts in process of a polymerization as matter which checks a polymerization, since it will become easy to be influenced of oxygen if there is not enough thickness of a mold cavity, the heterogeneity of a polymerization is caused and this also causes polymerization distortion. So, this invention enabled it to reduce generating of polymerization distortion sharply by setting the thickness 8 of a mold cavity as 0.3mm or more. Although the thickness of a mold cavity needed changes with the class of polymerization nature monomer to be used, and polymerization conditions, it should just be 0.3mm or more in general. It is 0.5mm or more still more preferably, it is thought that the homogeneity of a polymerization improves as thickness of a mold cavity is enlarged, but since it will lead to a cost rise when it not only consumes a polymerization nature monomer in large quantities, but the part which carries out cutting becomes large if it is made large beyond the need, it is desirable to set up suitably in 0.5-1.0mm.

[0032] Next, the polymerization method of the contact lens by this invention is described. The polymerization of this invention is performed in heat curing by heating under existence of the usual heat catalyst. It piles up so that the convex side of a male may agree in initial-complement discharge in the concave side of a female mold and may agree a polymerization nature monomer in this in a previous concave side. Under the present circumstances, the contact surface and the lateral portion contact surface of a mold warm to contact completely. In this way, it is suitable to heat the assembled mold with an atmospheric-air polymerization furnace or a warm water polymerization tank, and to carry out thermal polymerization.

[0033] A polymerization nature monomer applicable to this invention is a compound which is generally used and in which a radical polymerization is possible, is the compound which contains a vinyl group, an allyl group, an acrylic radical, or an methacrylic radical in [one or more] a molecule, and is matter usually used as a hard lens or a soft contact lens ingredient. Specifically, vinyl compounds, such as acrylic ester (meta), such as alkyl (meta) acrylate, siloxanyl (meta) acrylate, fluoro alkyl (meta) acrylate, hydroxyalkyl (meta) acrylate, polyethylene-glycol (meta) acrylate, acrylic ester (meta) of polyhydric alcohol, and vinyl (meta) acrylate, a derivative of styrene, N-vinyl lactam, and carboxylic-acid (multiple valued) vinyl, etc. are mentioned. Still

more specifically For example, styrene, an acrylic acid, methyl acrylate, Ethyl acrylate, n-butyl acrylate, phenyl acrylate, 2-hydroxyethyl acrylate, 2-hydroxypropyl acrylate, A methacrylic acid, methyl methacrylate, ethyl methacrylate, n-butyl methacrylate, 2-ethylhexyl methacrylate, isobornyl methacrylate, Benzyl methacrylate, phenyl methacrylate, 2-methacryloiloxy-ethyl succinic acid, 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, 2-hydroxy butyl methacrylate, fumaric acids and those ester, a methacrylonitrile, N,N-dimethylacrylamide, an N-vinyl-2-pyrrolidone, etc. are mentioned.

[0034] Furthermore, as a cross linking agent, ethylene GURIKORUJI (meta) acrylate, Diethylene GURIKORUJI (meta) acrylate, TORIECHIRENGURIKORUJI (meta) acrylate, Propylene GURIKORUJI (meta) acrylate, TORIMECHI roll pro pantry (meta) acrylate, Pen TAERISURITORUTORI (meta) acrylate, 1, 4-butane JIORUJI (meta) acrylate, Polyfunctional monomer, such as 1, 6-hexane JIORUJI (meta) acrylate, GURISERINJI (meta) acrylate, divinylbenzene diallyl phthalate, and diethylene-glycol bisallyl carbonate, can also be used.

[0035] It is necessary to carry out by choosing the polymerization method suitable for this, the class of polymerization initiator, an addition, etc. in consideration of the property of these polymerization nature monomers to be used, i.e., viscosity, the rate of a volumetric shrinkage, a rate of polymerization, etc.

[0036]

[Function] It is resin which can bear heat curing and heating annealing enough as the quality of the material of the plastic pattern used for it, and since the resin with an engine lathe in which cutting is possible is used, it can excel in the optical character and a mechanical strength, and the manufacture approach of the contact lens using the plastic pattern for contact lens manufacture and it by this invention can be performed by the blank mold method by heat curing, and the quality contact lens which has the smooth front face and the smooth edge which do not do damage to a cornea can be manufactured by low cost.

[0037]

[Example] Although an example explains in more detail below, this invention is not limited to these.

[0038] (Example 1) In this example, polypropylene was used as the quality of the material of a female mold which uses an ethylene-vinylalcohol copolymer (trade-name SOARAITOM: Nippon Synthetic Chemical Industry Co., Ltd. make) as the quality of the material of the male shown in drawing 1 , and sets the curvature of BC optical surface to 7.21mm, and is shown in drawing 2 , and the plastic pattern which set the curvature of FC forming face to 7.2mm, and was manufactured with injection molding was used. Moreover, thickness of the mold cavity formed when this male and female mold are combined was set to 0.5mm. As a polymerization nature monomer, 2, the 3-dihydroxy propyl methacrylate 70 weight section, the methyl methacrylate 28 weight section, the ethylene glycol dimethacrylate 1 weight section, and the azobis (2,4-dimethylvaleronitrile) 0.2 weight section were often mixed, and what performed degassing of this mixture and a nitrogen purge was used. The previous plastic pattern was filled up with this mixture, this was supplied in the thermostat of a hot blast circuit system, and it heated at 80 degrees C by 50 degrees C for 5 hours for 5 hours. Furthermore, the male which removed the female mold as annealing was thrown in in the annealing furnace of a hot blast circuit system, and it heated at 125 degrees C for 5 hours. Then, the male which the lens semifinished product has pasted up was attached in the engine lathe for lens cutting, the FC side of a lens was cut with the curvature of 7.70mm, and the FC side front face was ground. Furthermore, it cut so that the periphery convention section of a lens might become a smooth curve configuration, and the edge part was formed. Under the present circumstances, it carried out by [as making the cutting tool of the engine lathe for lens cutting cut deeply to the front face of a male]. The elution of an effluent was completed at the same time it was immersed in a physiological saline and carried out water absorption of the specified quantity, after making the obtained contact lens swell in pure water and washing it.

[0039] In this way, the obtained soft contact lens had a front face and the smooth edge section, and there was no opening in a contact lens front face and the interior. Moreover, power has -3.00D by 8.60mm, and BC of this soft contact lens was very excellent in optical-character ability. It had the reinforcement more than the

lens produced by the ball-race cutting method which are the average breaking strength of 192g, and 275% of average ductility, and furthermore used bar material about the mechanical strength, and an EQC.

[0040] In addition, evaluation of the reinforcement of a soft contact lens was carried out by the following approaches.

[0041] The soft contact lens (although thickness changes with frequencies, it is range which is 0.03mm - 0.1mm) of the moisture state by the physiological saline was used as the test piece, the load (breaking strength) when extending and going and fracturing this test piece across a vertical edge, at intervals of 8mm, in a physiological saline and the distance between the supporting points at that time (elongation) were measured, and it asked for average breaking strength and average ductility from that measured value.

[0042] (Example 2) In this example, polypropylene was used as the quality of the material of a female mold which uses polyacetal (trade-name Duracon M90-44: Polyplastics make) as the quality of the material of the male shown in [drawing 1](#) , and sets the curvature of BC optical surface to 7.25mm, and is shown in [drawing 2](#) , and the plastic pattern which set the curvature of FC forming face to 7.2mm, and was manufactured with injection molding was used. Moreover, thickness of the mold cavity formed when this male and female mold are combined was set to 0.3mm. As a polymerization nature monomer, the 2-hydroxyethyl methacrylate 97 weight section, the ethylene glycol dimethacrylate 2 weight section, and the azobis (2,4-dimethylvaleronitrile) 0.3 weight section were often mixed, and what performed degassing of this mixture and a nitrogen purge was used. The previous plastic pattern was filled up with this mixture, this was supplied in the thermostat of a hot blast circuit system, and it heated at 80 degrees C by 40 degrees C for 5 hours for 8 hours. The female mold was removed from the male after hardening, the male which the lens semifinished product has pasted up was attached in the engine lathe for lens cutting, the FC side of a lens was cut with the curvature of 7.70mm, and the FC side front face was ground. Furthermore, it cut so that the periphery convention section of a lens might become a smooth curve configuration, and the edge part was formed. Under the present circumstances, it carried out by [as making the cutting tool of the engine lathe for lens cutting cut deeply to the front face of a male]. The elution of an effluent was completed at the same time it was immersed in a physiological saline and carried out water absorption of the specified quantity, after making the obtained contact lens swell in pure water and washing it.

[0043] In this way, the obtained soft contact lens had a front face and the smooth edge section, and there was no opening in a contact lens front face and the interior. Moreover, power has -3.00D by 8.60mm, and BC of this soft contact lens was very excellent in optical-character ability. It had the reinforcement more than the lens produced by the ball-race cutting method which are the average breaking strength of 122g, and 325% of average ductility, and furthermore used bar material about the mechanical strength, and an EQC.

[0044] (Example 3) In this example, polypropylene was used as the quality of the material of a female mold which uses an ethylene-vinylalcohol copolymer (trade-name SOARAITOM: Nippon Synthetic Chemical Industry Co., Ltd. make) as the quality of the material of the male shown in [drawing 1](#) , and sets the curvature of BC optical surface to 6.60mm, and is shown in [drawing 2](#) , and the plastic pattern which set the curvature of FC forming face to 6.5mm, and was manufactured with injection molding was used. Moreover, thickness of the mold cavity formed when this male and female mold are combined was set to 0.5mm. As a polymerization nature monomer, the N,N-dimethylacrylamide 58 weight section, 2 and 2, and 2-trifluoroethylmethacrylate 25 weight section, the tris (trimethylsiloxy) silyl propyl methacrylate 10 weight section, 2, the 3-dihydroxy propyl methacrylate 5 weight section, the ethylene glycol dimethacrylate 1 weight section, and the t-butylperoxy perpivalate 0.5 weight section were often mixed, and what performed degassing of this mixture and a nitrogen purge was used. The previous plastic pattern was filled up with this mixture, this was supplied in the thermostat of a hot blast circuit system, and it heated at 80 degrees C by 40 degrees C for 10 hours for 8 hours. Furthermore, the male which removed the female mold as annealing was thrown in in the annealing furnace of a hot blast circuit system, and it heated at 130 degrees C for 5 hours. Then, the male which the lens semifinished product has pasted up was attached in the engine lathe for lens cutting, the FC side of a lens was

cut with the curvature of 7.06mm, and the FC side front face was ground. Furthermore, it cut so that the periphery convention section of a lens might become a smooth curve configuration, and the edge part was formed. Under the present circumstances, it carried out by [as making the cutting tool of the engine lathe for lens cutting cut deeply to the front face of a male]. The elution of an effluent was completed at the same time it was immersed in a physiological saline and carried out water absorption of the specified quantity, after making the obtained contact lens swell in pure water and washing it.

[0045] In this way, the obtained soft contact lens had a front face and the smooth edge section, and there was no opening in a contact lens front face and the interior. Moreover, power has -3.00D by 8.60mm, and BC of this soft contact lens was very excellent in optical-character ability. It had the reinforcement more than the lens produced by the ball-race cutting method which are the average breaking strength of 168g, and 388% of average ductility, and furthermore used bar material about the mechanical strength, and an EQC.

[0046] (Example 4) In this example, polypropylene was used as the quality of the material of a female mold which uses a polyamide (trade-name Arlen AE 4200: product made from Mitsui Petrochemistry) as the quality of the material of the male shown in drawing 1, and sets the curvature of BC optical surface to 6.90mm, and is shown in drawing 2, and the plastic pattern which set the curvature of FC forming face to 7.2mm, and was manufactured with injection molding was used. Moreover, thickness of the mold cavity formed when this male and female mold are combined was set to 1mm. As a polymerization nature monomer, 2, the 3-dihydroxy propyl methacrylate 70 weight section, the methyl methacrylate 28 weight section, the ethylene glycol dimethacrylate 1 weight section, and the azobis (2,4-dimethylvaleronitrile) 0.2 weight section were often mixed, and what performed degassing of this mixture and a nitrogen purge was used. The previous plastic pattern was filled up with this mixture, this was supplied in the thermostat of a hot blast circuit system, and it heated at 80 degrees C by 50 degrees C for 5 hours for 5 hours. Furthermore, the male which removed the female mold as annealing was thrown in in the annealing furnace of a hot blast circuit system, and it heated at 125 degrees C for 5 hours. Then, the male which the lens semifinished product has pasted up was attached in the engine lathe for lens cutting, the FC side of a lens was cut with the curvature of 7.65mm, and the FC side front face was ground. Furthermore, it cut so that the periphery convention section of a lens might become a smooth curve configuration, and the edge part was formed. Under the present circumstances, it carried out by [as making the cutting tool of the engine lathe for lens cutting cut deeply to the front face of a male]. The elution of an effluent was completed at the same time it was immersed in a physiological saline and carried out water absorption of the specified quantity, after making the obtained contact lens swell in pure water and washing it.

[0047] In this way, the obtained soft contact lens had a front face and the smooth edge section, and there was no opening in a contact lens front face and the interior. Moreover, power has -8.00D by 8.20mm, and BC of this soft contact lens was very excellent in optical-character ability. It had the reinforcement more than the lens produced by the ball-race cutting method which are the average breaking strength of 186g, and 263% of average ductility, and furthermore used bar material about the mechanical strength, and an EQC.

[0048] (Example 5) In this example, polypropylene was used as the quality of the material of a female mold which uses denaturation polyolefine (trade name ZEONEX280: Nippon Zeon Co., Ltd. make) as the quality of the material of the male shown in drawing 1, and sets the curvature of BC optical surface to 7.25mm, and is shown in drawing 2, and the plastic pattern which set the curvature of FC forming face to 7.2mm, and was manufactured with injection molding was used. Moreover, thickness of the mold cavity formed when this male and female mold are combined was set to 0.3mm. In addition, plasma treatment was performed to the male used here. As the approach of plasma treatment, this male was installed in plasma equipment and processing for 3 minutes was performed by the discharge frequency of 13.56MHz, and discharge power 200W among the argon ambient atmosphere of degree of vacuum 0.1Torr. As a polymerization nature monomer, the 2-hydroxyethyl methacrylate 97 weight section, the ethylene glycol dimethacrylate 2 weight section, and the azobis (2,4-dimethylvaleronitrile) 0.3 weight section were often mixed, and what performed degassing of this

mixture and a nitrogen purge was used. The previous plastic pattern was filled up with this mixture, this was supplied in the thermostat of a hot blast circuit system, and it heated at 80 degrees C by 40 degrees C for 5 hours for 8 hours. The female mold was removed from the male after hardening, the male which the lens semifinished product has pasted up was attached in the engine lathe for lens cutting, the FC side of a lens was cut with the curvature of 7.70mm, and the FC side front face was ground. Furthermore, it cut so that the periphery convention section of a lens might become a smooth curve configuration, and the edge part was formed. Under the present circumstances, it carried out by [as making the cutting tool of the engine lathe for lens cutting cut deeply to the front face of a male]. The elution of an effluent was completed at the same time it was immersed in a physiological saline and carried out water absorption of the specified quantity, after making the obtained contact lens swell in pure water and washing it.

[0049] In this way, the obtained soft contact lens had a front face and the smooth edge section, and there was no opening in a contact lens front face and the interior. Moreover, power has -3.00D by 8.60mm, and BC of this soft contact lens was very excellent in optical-character ability. It had the reinforcement more than the lens produced by the ball-race cutting method which are the average breaking strength of 128g, and 338% of average ductility, and furthermore used bar material about the mechanical strength, and an EQC.

[0050] (Example 6) In this example, polypropylene was used as the quality of the material of a female mold which uses an ethylene-vinylalcohol copolymer (trade-name SOARAITOM: Nippon Synthetic Chemical Industry Co., Ltd. make) as the quality of the material of the male shown in drawing 1 , and sets the curvature of BC optical surface to 6.60mm, and is shown in drawing 2 , and the plastic pattern which set the curvature of FC forming face to 6.5mm, and was manufactured with injection molding was used. Moreover, thickness of the mold cavity formed when this male and female mold are combined was set to 0.5mm. As a polymerization nature monomer, the N,N-dimethylacrylamide 58 weight section, 2 and 2, and 2-trifluoroethylmethacrylate 25 weight section, the tris (trimethylsiloxy) silyl propyl methacrylate 10 weight section, 2, the 3-dihydroxy propyl methacrylate 5 weight section, the ethylene glycol dimethacrylate 1 weight section, and the t-butylperoxy perpivalate 0.5 weight section were often mixed, and what performed degassing of this mixture and a nitrogen purge was used. The previous plastic pattern was filled up with this mixture, this was supplied in the thermostat of a hot blast circuit system, and it heated at 80 degrees C by 40 degrees C for 10 hours for 8 hours. Furthermore, the male which removed the female mold as annealing was thrown in in the annealing furnace of a hot blast circuit system, and it heated at 130 degrees C for 5 hours. Then, the male which the lens semifinished product has pasted up was attached in the engine lathe for lens cutting, the FC side of a lens was cut with the curvature of 7.06mm, and the FC side front face was ground. Furthermore, it cut so that the periphery convention section of a lens might become a smooth curve configuration, and the edge part was formed. Under the present circumstances, it carried out by [as making the cutting tool of the engine lathe for lens cutting cut deeply to the front face of a male]. The obtained contact lens was released from mold in the dry condition, and plasma treatment was performed to this lens. As the approach of plasma treatment, the contact lens of a dry condition was installed in plasma equipment, and processing for 5 minutes was performed by the discharge frequency of 13.56MHz, and discharge power 100W among the oxygen ambient atmosphere of degree of vacuum 0.02Torr. The elution of an effluent was completed at the same time it was immersed in a physiological saline and carried out water absorption of the specified quantity, after making this swell in pure water and washing it.

[0051] In this way, the obtained soft contact lens had a front face and the smooth edge section, and there was no opening in a contact lens front face and the interior. Moreover, power has -3.00D by 8.60mm, and BC of this soft contact lens was very excellent in the wettability on optical-character ability and the front face of a lens. It had the reinforcement more than the lens produced by the ball-race cutting method which are the average breaking strength of 156g, and 363% of average ductility, and furthermore used bar material about the mechanical strength, and an EQC.

[0052] (Example 7) In this example, polypropylene was used as the quality of the material of a female mold

which uses polybutylene terephthalate (trade-name tough pet PBT-N1000: Mitsubishi Rayon Co., Ltd. make) as the quality of the material of the male shown in drawing 1 , and sets the curvature of BC optical surface to 6.60mm, and is shown in drawing 2 , and the plastic pattern which set the curvature of FC forming face to 6.5mm, and was manufactured with injection molding was used. Moreover, thickness of the mold cavity formed when this male and female mold are combined was set to 0.5mm. As a polymerization nature monomer, the N,N-dimethylacrylamide 58 weight section, 2 and 2, and 2-trifluoroethylmethacrylate 25 weight section, the tris (trimethylsiloxy) silyl propyl methacrylate 10 weight section, 2, the 3-dihydroxy propyl methacrylate 5 weight section, the ethylene glycol dimethacrylate 1 weight section, and the t-butylperoxy perpivalate 0.5 weight section were often mixed, and what performed degassing of this mixture and a nitrogen purge was used. The previous plastic pattern was filled up with this mixture, this was supplied in the thermostat of a hot blast circuit system, and it heated at 80 degrees C by 40 degrees C for 10 hours for 8 hours. Furthermore, the male which removed the female mold as annealing was thrown in in the annealing furnace of a hot blast circuit system, and it heated at 130 degrees C for 5 hours. Then, the male which the lens semifinished product has pasted up was attached in the engine lathe for lens cutting, the FC side of a lens was cut with the curvature of 7.06mm, and the FC side front face was ground. Furthermore, it cut so that the periphery convention section of a lens might become a smooth curve configuration, and the edge part was formed. Under the present circumstances, it carried out by [as making the cutting tool of the engine lathe for lens cutting cut deeply to the front face of a male]. The elution of an effluent was completed at the same time it was immersed in a physiological saline and carried out water absorption of the specified quantity, after making the obtained contact lens swell in pure water and washing it.

[0053] In this way, the obtained soft contact lens had a front face and the smooth edge section, and there was no opening in a contact lens front face and the interior. Moreover, power has -3.00D by 8.60mm, and BC of this soft contact lens was very excellent in optical-character ability. It had the reinforcement more than the lens produced by the ball-race cutting method which are the average breaking strength of 178g, and 400% of average ductility, and furthermore used bar material about the mechanical strength, and an EQC.

[0054] (Example 1 of a comparison) In this example of a comparison, except using polypropylene as the quality of the material of the male shown in drawing 1 , it carried out like the example 1 and the contact lens was obtained. The elution of an effluent was completed at the same time it was immersed in a physiological saline and carried out water absorption of the specified quantity, after making it swell in pure water like an example 1 and washing.

[0055] In this way, a surface precision was inferior in the obtained soft contact lens compared with the contact lens obtained in the example 1, and its optical-character ability was inadequate.

[0056] (Example 2 of a comparison) In this example of a comparison, except setting the thickness of the mold cavity formed when a male and a female mold are combined as 0.1mm, it carried out like the example 1 and the contact lens was obtained. The elution of an effluent was completed at the same time it was immersed in a physiological saline and carried out water absorption of the specified quantity, after making it swell in pure water like an example 1 and washing.

[0057] In this way, the obtained soft contact lens had inadequate optical-character ability compared with the contact lens which polymerization distortion arose and was obtained in the example 1. Moreover, about the mechanical strength, it was less than the reinforcement of the contact lens which are the average breaking strength of 112g, and 225% of average ductility, and was obtained in the example 1.

[0058]

[Effect of the Invention] According to invention of claim 1 and claim 5, the plastic pattern for contact lens manufacture, and the manufacture approach of the contact lens using it Since it is resin which can bear heat curing and heating annealing enough as the quality of the material of the plastic pattern which performs by the blank mold method by heat curing, and is used for it and the resin with an engine lathe in which cutting is possible is used, It excels in the optical character and the quality contact lens which has the smooth front face

and smooth edge which do not do damage to a cornea can be manufactured by low cost.

[0059] According to invention of claim 2 and claim 6, since the thickness of the space formed when the male and female mold of a plastic pattern are combined was set as 0.3mm or more, polymerization distortion is suppressed, and the plastic pattern for contact lens manufacture and the manufacture approach of the contact lens using it can manufacture the quality contact lens excellent in the optical character and a mechanical strength by low cost.

[Translation done.]